Introduction to Programming

Lecture 3: arrays and even more Processing

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Fighter problem

- Say we have five fighter jets that we want to move across the screen
- We keep track of their x and y coordinates

```
1  int x1, x2, x3, x4, x5, y1, y2, y3, y4, y5;
2
3  void draw() {
4    point(x1, y1);
5    point(x2, y2);
6    point(x3, y3);
7    point(x4, y4);
8    point(x5, y5);
9  }
```

Fighter problem

- The fleet commander sends an additional 1000 fighters
- Do you really want to make 2000 variables?
- Do you really want repetetive code?

Solutions

Use arrays to keep track of information

Arrays

- An array is a list of objects of the same type
- An array x with three elements has variables with names x_0, x_1, x_2
- A book is an array of pages
- A string is an array of characters
- The order is important

Arrays by example

```
1  int[] x = new int[4]; // make room for 4 ints
2  x[0] = 5; // assign to the first the value 5
```

- Makes 4 int variables named x[0], x[1], x[2], and x[3]
- Sets the first element to 5
- The default value is 0

Arrays by example

```
1  char[] x = new char[5];
2  x[0] = 'H';
3  x[1] = 'e';
4  x[2] = 'l';
5  x[3] = 'l';
6  x[4] = 'o';
7
8  for (int i = 0; i < 5; i++) {
9    print(x[i]);
10 }
```

```
Hello
```

Shorthand notation

```
1  char[] x = {'H','e','l','l','o'};
2
3  for (int i = 0; i < 5; i++) {
4    print(x[i]);
5  }
```

```
Hello
```

Arrays by example

Our fighter example:

```
1  int[] x = new int[5];
2  int[] y = new int[5];
3
4  void draw() {
5    for (int i = 0; i < 5; i++)
6        point(x[i], y[i]);
7  }
```

Array length

You can get the length of array:

```
1  int[] x = new int[5];
2  println(x.length);
```

5

Example

```
1  int[] x = new int[100];
2
3  for (int i = 0; i < x.length; i++)
4    x[i] = random(100);
5
6  int max = 0;
7  for (int i = 0; i < x.length; i++)
8    if (x[i] > max)
9      max = x[i];
10
11 println(max);
```

2d arrays

- An array could have more than one dimension
- A grid could be viewed as a 2d array
- Each row is an array
- We have an array of rows

2d arrays

Construction:

```
1 int[][] grid = new int[5][5]; // 5 by 5 matrix
2 grid[1][2] = 10; // row 2, column 3
```

2d arrays

Coordinates in a 5x5 grid:

$(0, 0)$	$(1, 0)$	$(2, 0)$	$(3, 0)$	$(4, 0)$
$(0, 1)$	$(1, 1)$	$(2, 1)$	$(3, 1)$	$(4, 1)$
$(0, 2)$	$(1, 2)$	$(2, 2)$	$(3, 2)$	$(4, 2)$
$(0, 3)$	$(1, 3)$	$(2, 3)$	$(3, 3)$	$(4, 3)$
$(0, 4)$	$(1, 4)$	$(2, 4)$	$(3, 4)$	$(4, 4)$

- `grid[3][2]` is (2,3)
- First index is row (y coordinate)
- Second index is column (x coordinate)

2d arrays

You could code an image in an array:

```
int[][] grid = {{1,0,0,0}, {0,1,0,0},
                {0,0,1,0}, {0,0,0,1}};

for (int y = 0; y < grid.length; y++)
  for (int x = 0; x < grid[y].length; x++) {
    if (grid[y][x] == 1)
      fill(#ffffff);
    else
      fill(#000000);
    rect(x * 20, y * 20, 20, 20);
  }
```

Indexing

- You can turn a grid into a 1d array by concatenating the rows:

$(0,0)$	$(1,0)$	$(2,0)$	$(3,0)$
$(0,1)$	$(1,1)$	$(2,1)$	$(3,1)$

$\downarrow$

0	1	2	3	4	5	6	7
(0,0)	(1,0)	(2,0)	(3,0)	(0,1)	(1,1)	(2,1)	(3,1)

- Width of each row is 4
- Index of (2,1) is $4 \cdot 1 + 2$
- Index of (m, n) in a 2d array with width k is $k \cdot n + m$
- In reverse: index i gives coordinates $(i\%k, i/k)$

Images

Images are of type PImage:

```
1  PImage mario;
2
3  void setup() {
4    size(640,640);
5    mario = loadImage("mario.png");
6  }
7
8  void draw() {
9    image(mario, 320, 320, 150, 200);
10 }
```

Images

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```

Images

You can get the pixels of the image:

```
1 PImage mario = loadImage("mario.png");
2 mario.loadPixels(); // prepare pixel array
3
4 mario.pixels[100] = color(255, 102, 204);
```

- Pixels are a 1d array
- Use the width of the image `mario.width` to calculate coordinates

Final assignment

- You probably know enough of programming to start your final assignment
- When you have an idea for a game, make sure to verify it with me
- We will discuss some of your ideas during the lectures next week
- Writing a game takes time, so start early!